

SET OF WELL LOCATION DETERMINATION, DRILLING, COMPLETION, AND PRODUCTION METHODS IN RE-DEVELOPMENT OF A MATURE FIELD

Hari Karyadi Oetomo

Petroleum Engineering Department, College of Earth Technology and Energy,
Universitas Trisakti, Jakarta 11440, Indonesia

Email: hari.oetomo@trisakti.ac.id, Telp.: 021-5663232 ext 8509

ABSTRACT

XYZ oil field has been on production for 30 years, and has produced 189 MMBO of oil out of 491 MMBO of Original Oil in Place. The reservoir consists of reefal limestone carbonate rock. Initially, oil production was mainly coming from reservoir fracture; while rock matrix acted as secondary porosity. The field is the largest field in the area, with 40% of recovery factor. This number is high, but comparing to other fields with the same reservoir flow characteristics in the adjacent area, this number is the lowest. By increasing recovery factor of 0.5%, it will add 2 MBO of oil reserves, which is still feasible to be further re-developed. Several last well being drilled were using specifics methods which are different from previous wells' methods; and the results were successful. The methods are conventional method which included well location determination by using engineering maps, drilling technique, completion technique and production methods. The preliminary result of the field re-development yield to 40% water cut wells in the area with wells of 98% water cut.

Keywords: *recovery factor, mature field, development well location*

INTRODUCTION

XYZ field was discovered in 1973 from drilling XYZ-1 the discovery well. The main producing reservoir is carbonate limestone reservoir. Before initiating the XYZ field re-development program, there are a total of 282 wells drilled penetrated the reservoir, of which 142 wells are producing by pumping and 140 wells are non-producing wells with 4,136 BOPD oil production, 99.0% water cut and 187 MMBO cumulative oil.

The Original Oil in Place of the field is 489 MMBO with 196 MMBO of Estimated Ultimate Recovery or 40% Recovery Factor.

The Recovery Factor of the field is relatively low, providing that the reservoir has a very strong water drive, proved by the slight decline of the reservoir pressure after thirty years of production. Comparing to other fields in the adjacent area, that have recovery factor of more than 50%, the XYZ field Recovery Factor is low.

There are opportunities to drill additional development wells to improve oil recovery of the field.

The reservoir lithology of XYZ field is reefal carbonate limestone of late Miocene age. The trap is stratigraphic trap. The field is divided into several blocks separated by sealing faults (Figure 1). The reservoir is naturally fracture with very heterogeneous in rock properties. The reservoir has up to 570 feet of vertical oil column with 3720 acres of areal extent. The reservoir depth is around 2900 feet subsea.

The drive mechanism is very strong water drive reservoir, as pressure only declined around 40 psi from its original condition of 1160 psi with average permeability of 18 mD. Reservoir property is depicted in Figure 2.

This initial field re-development starts in right-most block by drilling new six XYZ wells with specific methods for well location, drilling, completing and producing the wells. The methods included well location determination by using engineering maps, drilling technique, completion technique and production methods.

WELL LOCATION

A simple methods of bubble map, cumulative oil map, cumulative oil/ net pay maps are used as the first step of selecting a well location. Figure 3 through 5 show the maps used for selecting well location in right-most block of XYZ Field.

Second step is evaluating the production performance of existing wells in the prospective area for new well, including their history.

Since heterogeneity is very high in the field, un-swept oil and un-drained oil has to be kept in mind as the target zone. The un-drained oil, either from tight zone or porous zone due to bad performance of surrounding wells. The un-swept oil is mainly due to bad performance of surrounding wells. Figure 6 is the list of surrounding/ existing wells property to be considered for a potential location.

Analytically, from surrounding well data, the un-swept and un-drained oil can be approximately located, thus water bearing zones can be avoided.

DRILLING

A very low mud weight, as low as possible for water base mud, is used during drilling XYZ Formation. Induced fracture has to be avoided as hard as possible. A fracture well will almost guarantee resulting in low oil producing well. A mud weight as low 8.4 ppg does not guarantee no loss circulation during drilling XYZ formation.

In the previous wells, the lowest mud weight used was 8.6 ppg. This high mud weight certainly will give a high possibility of loss circulation, which than causing induced fracture, in the XYZ formation

COMPLETION

During the initial field development, 7" casing was set from surface to TD of around 3000' with surface casing to around 800'. The new wells have to have 7" liner from top XYZ to TD of around 50 feet above the Original Oil Water contact, in order to have low drilling mud when drilling XYZ formation. During drilling above XYZ formation, higher mud weight is used to eliminate the effect of clay swelling. The 7" casing is used to avoid any operational problems. Figure 7 is the comparison of casing design.

During completion, any high pressure stimulation job or cement squeeze will not be done, unless really necessary, as they would promote induced fracture to the formation. In the previous well completion, high pressure stimulation and cement squeeze job are common practices.

PRODUCTION

Low fluid rate has to be applied to the wells, to ensure a piston-like displacement taken place in the reservoir. In the previous practice, high fluid rate is necessary for a well, to ensure the oil production of the worm-hole.

RESULT

The first re-development well XYZ-301, a lot of learning was done on this well. However, this well is a successful well as water cut was around 40% in the area with wells of 99% water cut. Figure 8 through is the production performance of the first 4 wells.

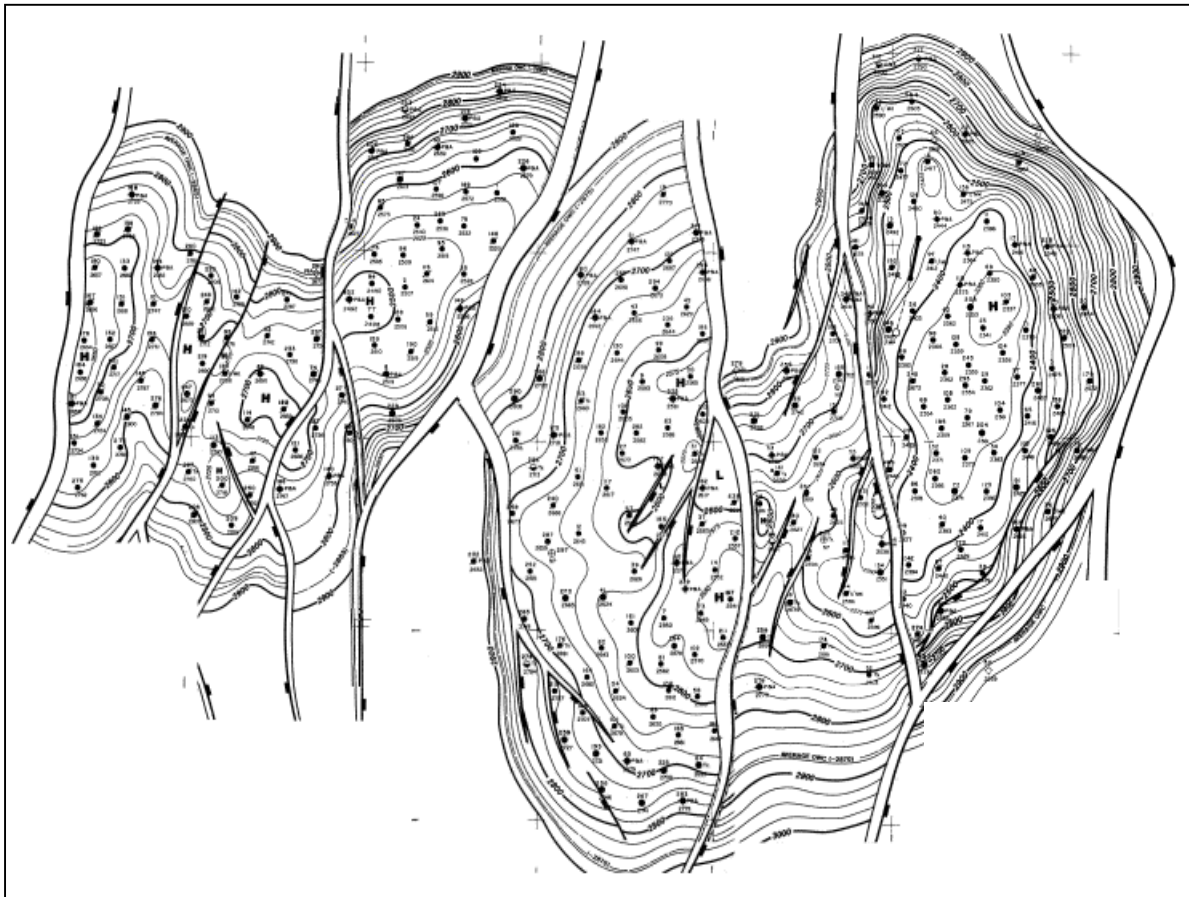
The last two wells, severe loss circulations had occurred that caused the wells performed not as expected. The loss circulation causing induced fracture, which lead the well to produce high water cut, by passed the oil bearing zones.

CONCLUSION

1. Conventional methods are proven to successful in re-developing old and mature field.
2. Placing a well location is very important for re-developing old and mature field.
3. Drilling practice has to be reviewed for better result, in this case by using very low mud weight in the target formation.
4. In the well casing design, not only economical factor is considered, the drilling practice and the need to have optimum result are very important.
5. Reservoir management by producing a well at optimum not maximum rate is required.
6. As this is an on-going project, the need to improve the operational conventional method in the future is a must. The future locating a well has to be improved for more optimum location. Mud weight has to be reduced by the use of low density agent. Casing design can be improved with the improvement of drilling practice. The need to established the optimum fluid rate procedure.

REFERENCES

- Ahmed, Tarek, "Reservoir Engineering Handbook Fourth Edition", Gulf Professional Publishing, Houston, Texas, 2010.
- Brown, Kermit E., "The Technology of Artificial Lift Methods", Volume 1, Petroleum Publishing Company, Tulsa, Oklahoma, 1983.
- Rukmana, Dadang. Teknik Reservoir Teori dan Aplikasi, Percetakan Pohon Cahaya, Jakarta, 2012.
- Brown, Kermit E., "The Technology of Artificial Lift Method", Volume 4, Petroleum Publishing Company, Tulsa, Oklahoma, 1984.
- Takacks, Gabor, "Electric Submersible Pumps Manual Design, Operations, and Maintenance", Gulf Publishing Of Elsevier, Oxford, UK, 2009.
- Arnold, Ken dan Maurice Stewart. Surface Production Operations Volume 1. Houston, Texas: Gulf Publishing Company. 1991.
- Adam, Neal, "Drilling Engineering", Pennwell Publishing Company, Tulsa, Oklahoma, 1985.
- Rabia, H., "Oilwell Drilling Engineering: Principle and Practice", Graham and Trotman Inc., Texas, 1985

Figure 1**Figure 2****Property of XYZ Field**

Average Pay Depth	2650 feet	Original Reservoir Pressure	1162 psig
Maximum Oil Column	573 feet	Average Porosity	20.7% (Log)
Productive Area	3,720 acres	Average Water Saturation	35.0% (Log)
Average Net Pay Thickness	243 feet	Average Permeability	18 mD (Core)
Saturation Pressure	100 psig	Pressure Reservoir Pressure	889-1129 psig
GOR	85 scf/bbl	Reservoir Temperature	176°F
B _o	1.06 rb/stb		

Figure 3

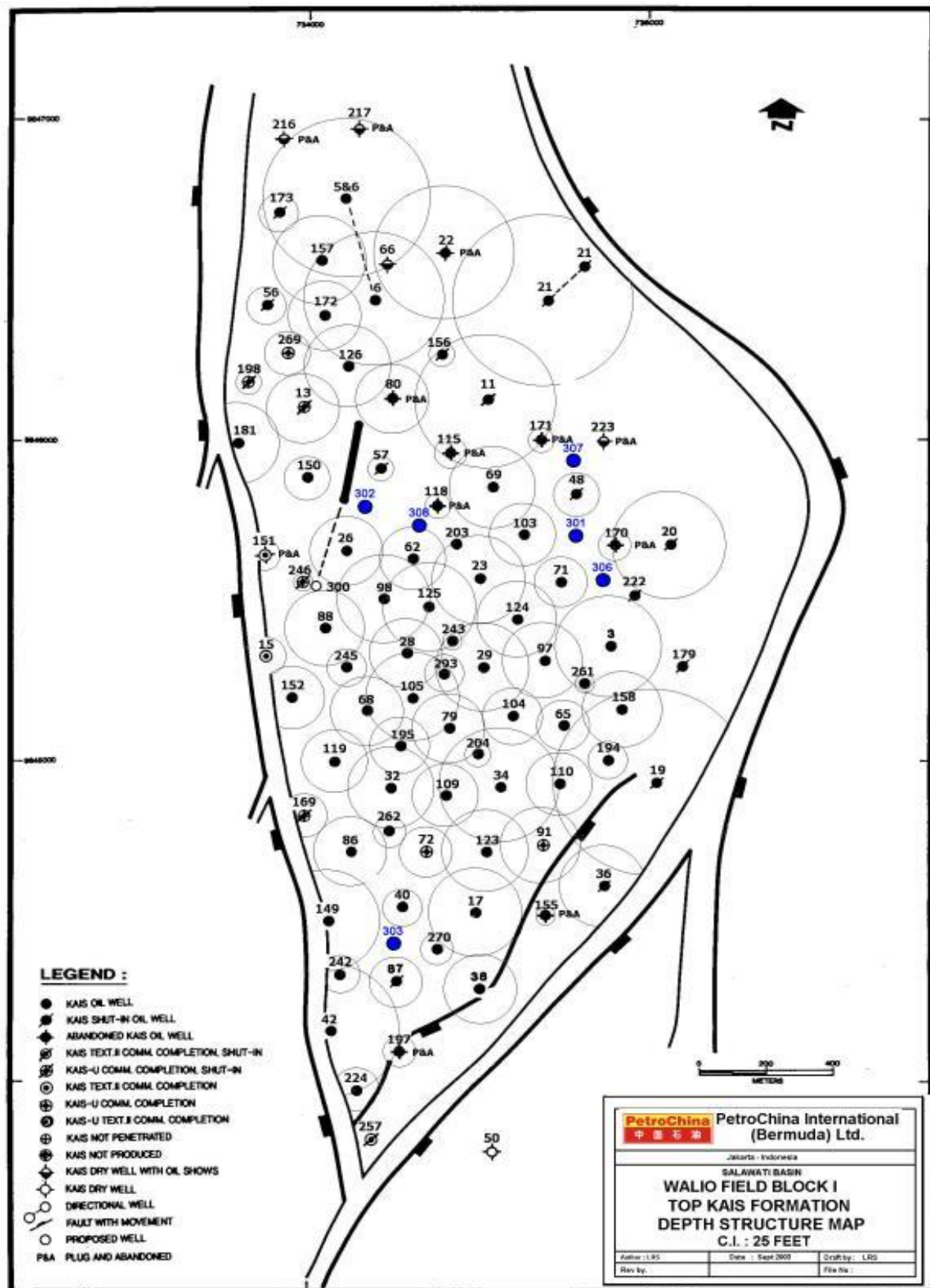


Figure 4

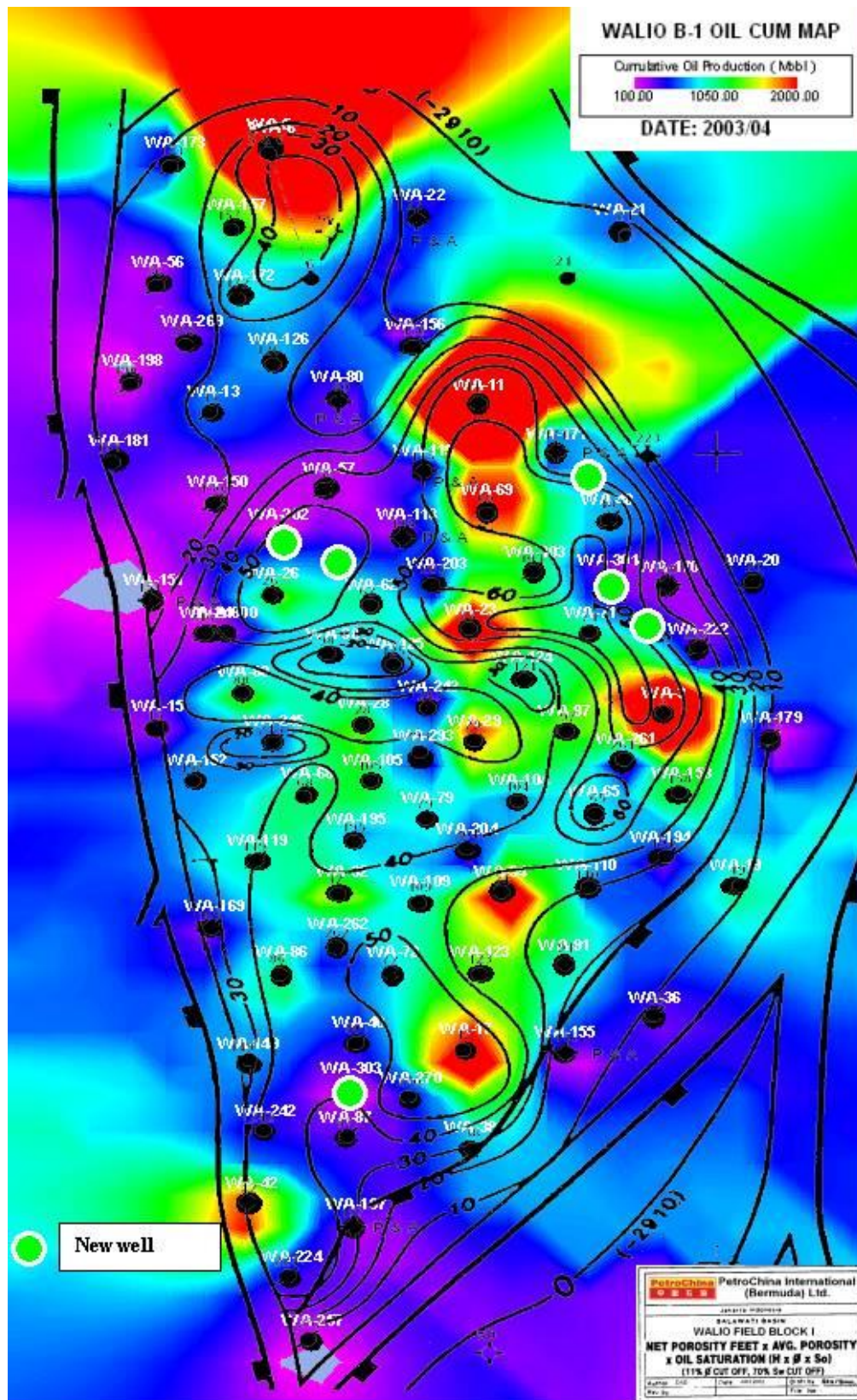


Figure 5

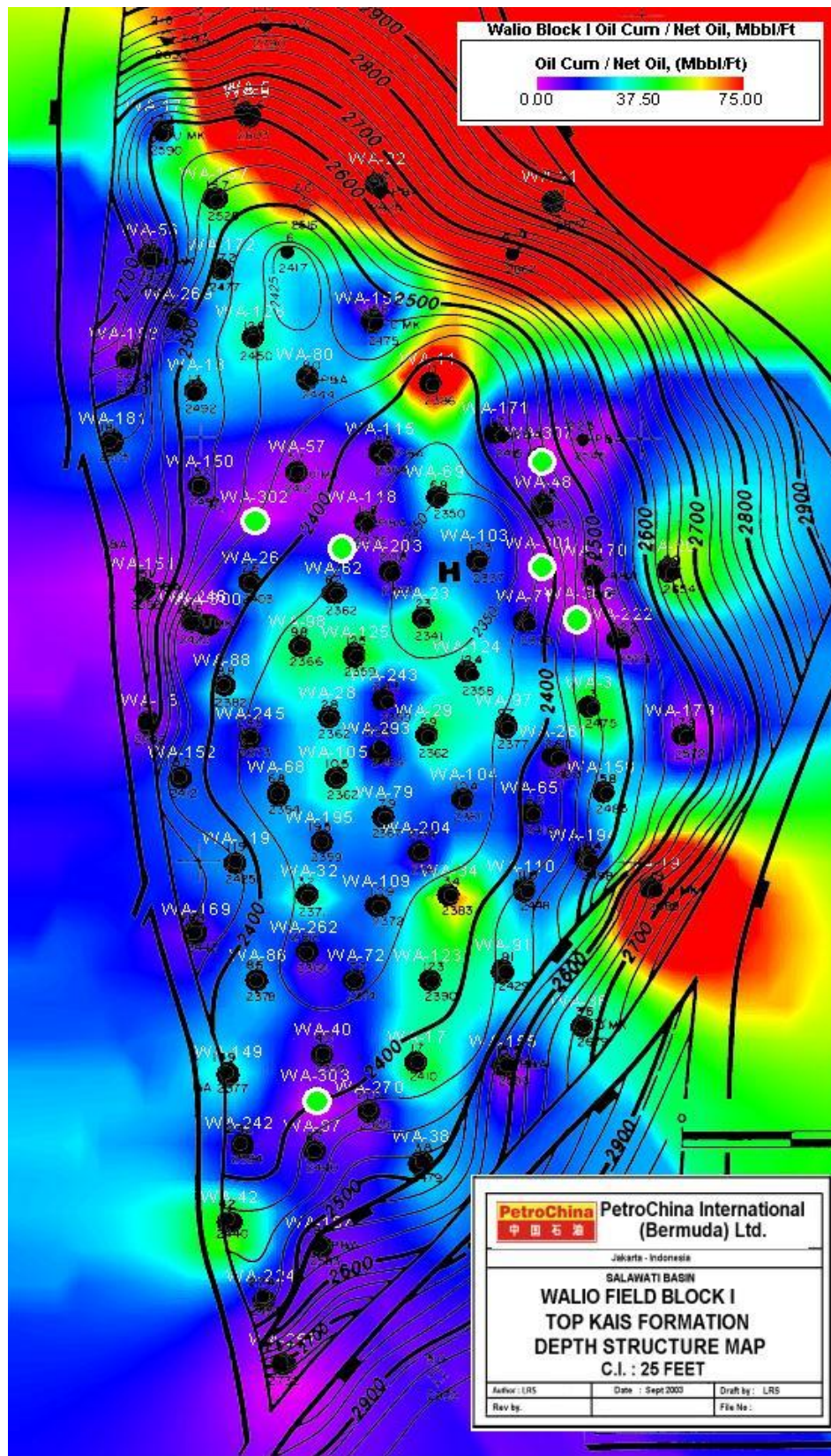


Figure 6

Required Surrounding Well Data

Production Data/Performance

Initial Rate and Water Cut

Last Rate and Water Cut

Status: shut-in/pumping

Mud Weight for Drilling XYZ Formation

Estimated Ultimate Recovery

Cumulative Production

Well History

Wellbore Diagram

Logs

Figure 7

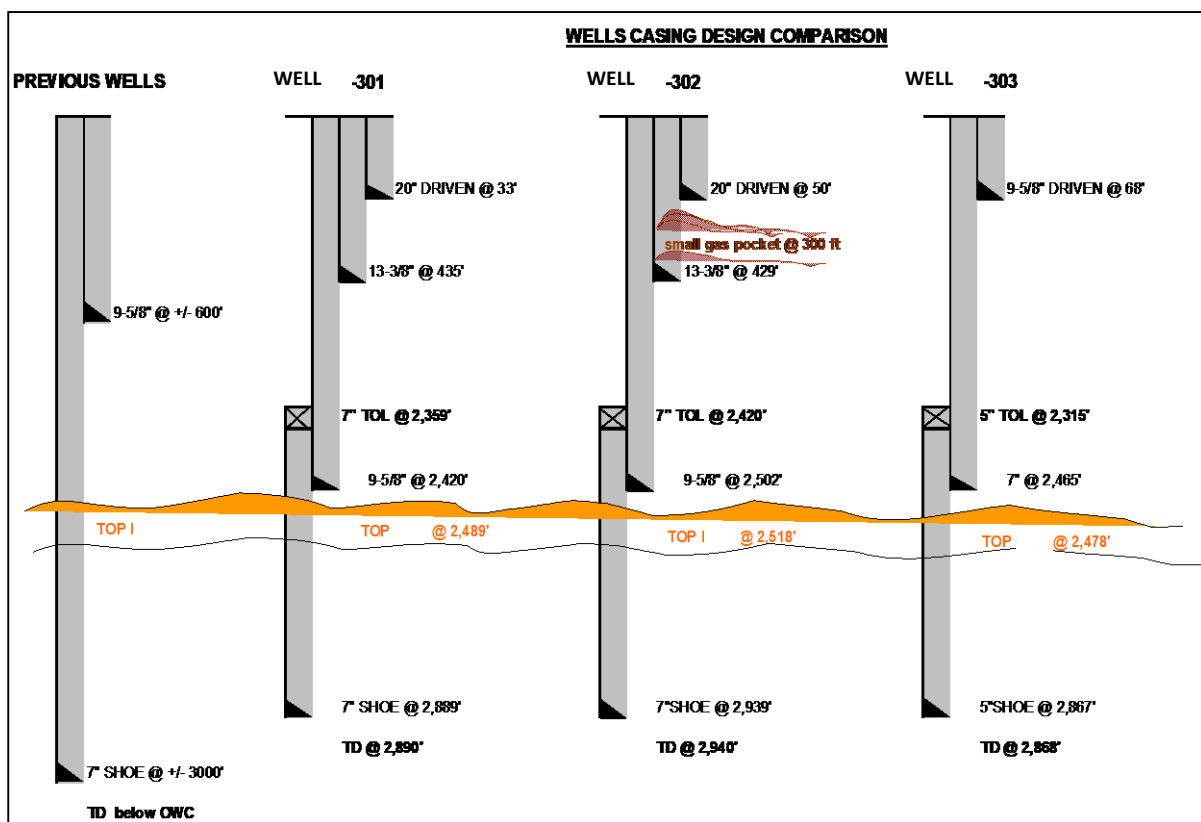


Figure 8

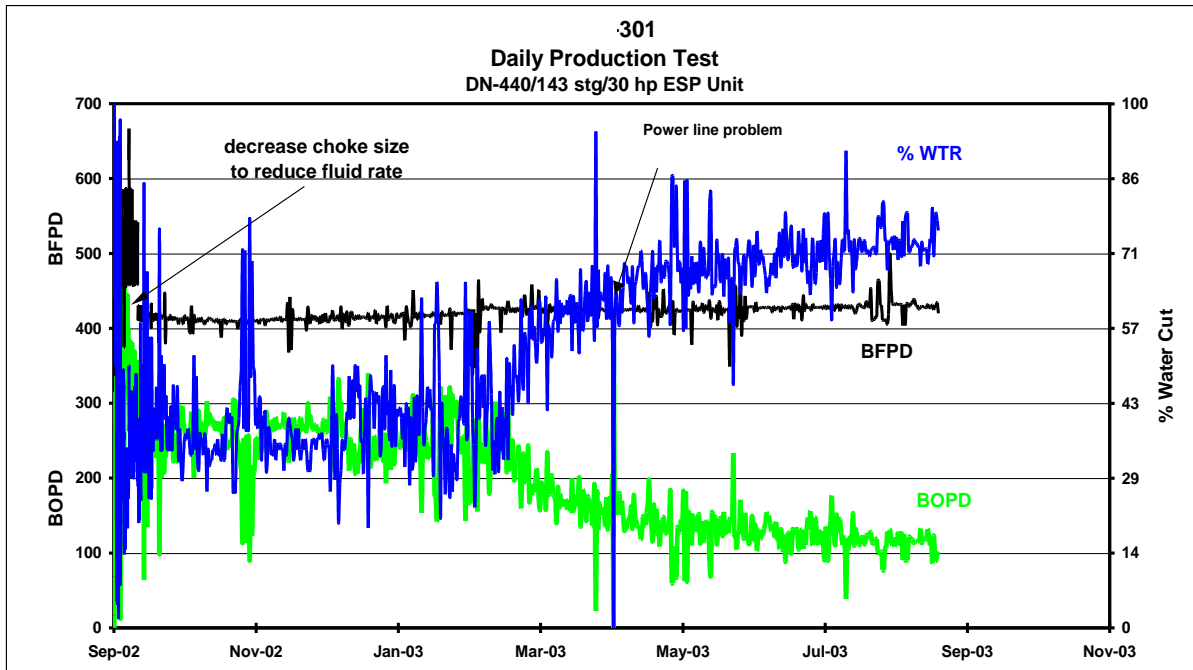


Figure 9

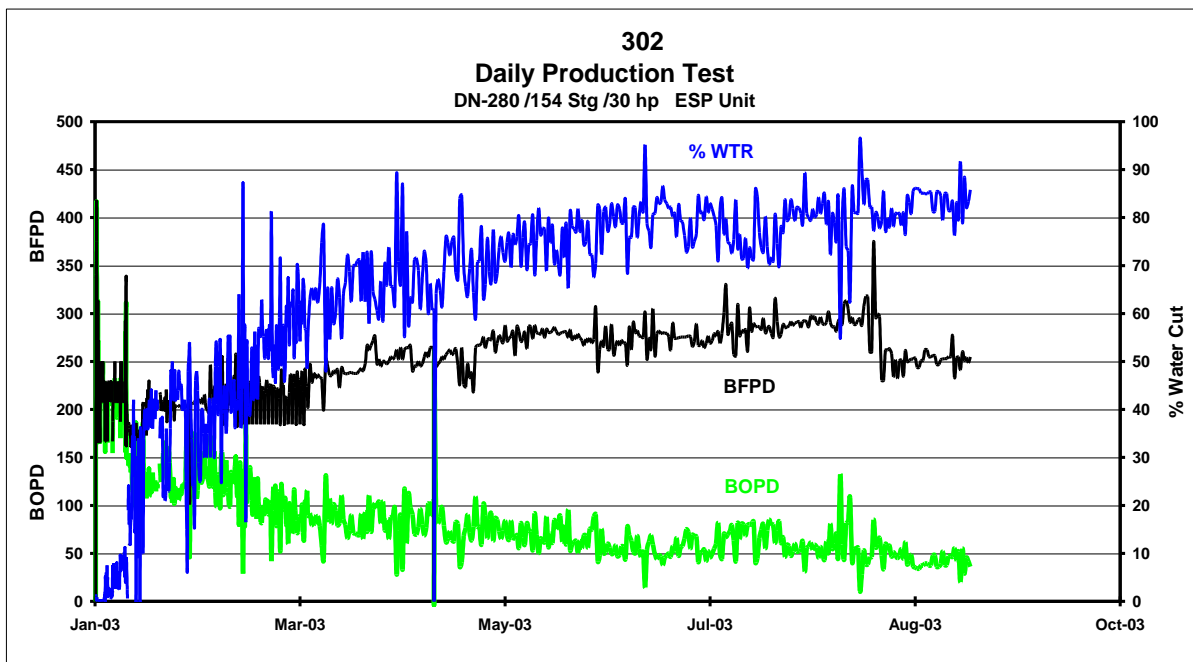


Figure 10

